REMARKS

Claims 1-19 remain in the application with independent claim 1 amended to more particularly define the invention and further distinguish the cited prior art.

The Examiner has indicated that claims 5-13 would be allowable if rewritten in independent form.

Reconsideration is respectfully requested for claims 1-4 and 14-19 as amended.

Claims 1-4 and 14-19 have been rejected under 35 USC 103(a) as being unpatentable over Glover et al. 5,225,781 in view of Xiang et al. 6,091,243. The Examiner notes that Glover uses a least square fitting method to unwrap phase and not to differentiate water from fat as in the claimed method of obtaining magnetic resonance signals with signal separation, the Examiner alleging that Xiang teaches a water-fat imaging with direct phase encoding and in which optimal averaging is employed to obtain a water and fat solution using equations 43-45, the Examiner further alleging that the optimal averaging is with a complex valued or real valued least square error (LSE) method known in the art.

This rejection is respectfully traversed with respect to claim 1 as amended and dependent claims 2-4, and 14-19.

As previously noted, the claimed invention is directed to a method of obtaining magnetic resonance signals with signal separation for at least two chemical species in a heterogeneous magnetic field using rapid gradient echo imaging including the steps of a) obtaining first magnetic resonance signals from pixels, b) obtaining at least second and third magnetic resonant signals from the pixels, and c) determining a signal estimate for each species and for each pixel by combining all signals for the pixel using a linear least squares fitting of the signals from each pixel to decompose the chemical species. As now amended, the least square fitting is used directly on all measured signals..

As will be described further hereinbelow, the cited Xiang et al. patent does not operate directly on measured signals, but as noted in the Summary of the Invention, Xiang must use a known statistical bias to identify components, and a correction by applying various filters to all filters is necessary. See also Xiang claims 2 and 3. On the other hand, the claimed invention operates directly on measured data. Also, Xiang does not employ a linear least squares fitting but rather uses an averaging technique on the measured data after processing using filters and a statistical bias.

As previously noted and as recognized by the Examiner, the cited Glover et al. patent uses a least squares method to resolve ambiguities in phase for a measured phase which can "wrap around" for phase angles greater than $\pi/2$. Glover et al. are not using a least square fitting method to differentiate water from fat.

Xiang teaches a water-fat imaging, but as the Examiner notes, Xiang uses an optimal averaging in separating water from fat and not a least square estimation to separate water from

fat as defined in claim 1 as amended. Note the equations for water and fat given by equations 46, 47 and 48 and the described averaging of the solutions of the three equations as given in column 14, line 59 through column 15, line 15 where a water image is expressed as a weighted averaging and not as least square error.

Xiang does employ an optimal averaging, as noted by the Examiner, which is described in column 16, lines 39-51 which Xiang alleges is actually identical in solution to the water and fat solution obtained from equations 43-45 using a real valued least square error method. However, Xiang is not using a real valued least square error method, but rather an optimal averaging which Xiang states is identical to the value obtained using a least square error method. Moreover, Xiang is not operating as measured, as claimed, but on processed data.

Xiang is actually using an analytical solution for the three equations for water and fat in an over-determined system in which there is not a single analytical solution, but many in general. The analytical solution as employed by Xiang will not have the best noise performance when compared to a least squares regression as in the claimed invention.

Xiang does recognize that the noise performance in his method is sub-optimal using one analytical solution. Therefore, Xiang calculates the three possible analytical solutions using equations 46-48. Then, Xiang takes a weighted average of these solutions (equation 52). This is a solution that has better noise performance, and has equivalent noise performance to a "least square error (LSE)" as Xiang notes in column 16, at line 50.

Thus, the claimed invention obtains a least squares solution of water-fat separation using a least squares regression, while Xiang uses averaging of analytical solutions to allegedly obtain an equivalent for identical water-fat separation using averaging of analytical solution. In addition, as noted by claim 6, the iterative least squares approach is used to solve for field map or error in field heterogeneity, whereas Xiang uses only an analytical solution to solve for what is termed "phase error" or "smooth phasors". The claimed approach using a least squares method has better noise performance as compared to the Xiang averaging approach.

For the forgoing reasons, it is respectfully submitted that the claimed method of obtaining magnetic resonance signals with signal separation for chemical species as defined by claim 1 as amended and dependent claims 2-3 and 14-19 is not suggested by Glover et al. taken with Xiang et al.

Since the Examiner has indicated that claims 5-13 are allowable, since claims 1-4 and 14-19 as amended are patentable under 35 USC 103(a) over Glover et al. in view of Xiang et al., all as above set forth, it is requested that claims 1-4 and 14-19 as amended along with claims 5-13 be allowed and the case advanced to issue.

Should the Examiner have any question or comment concerning the present amendment and response, a telephone call to the undersigned attorney is requested.

Respectfully submitted,
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